Development of Strained-Layer Superlattice (SLS) IR Detector Camera Project

Completed Technology Project (2012 - 2013)

Project Introduction

Strained Layer Superlattice (SLS) detectors are a new class of detectors which may be the next generation of band-gap engineered, large format infrared detector arrays with substantially higher quantum efficiencies than existing quantum well infrared photodetectors (QWIPs) and provide a competitive alternative to the current state-of-the-art mercury cadmium telluride and QWIP detector arrays. The anticipated advantages of SLS detector technology over existing IR detectors are: high sensitivity, band-gap tunable wavelength response (similar to QWIPs), warmer operating temperatures, array spectral uniformity (yet to be realized), high temporal stability, relatively low cost of manufacturing, scalability (to very large format arrays) and multiple vendor sources all contributing to higher performing scientific instruments. Previously, (in our FY12 IRAD "Strained Layer Superlattice Infrared Detector Array Characterization") we verified that these devices exhibit a dramatic increase in quantum efficiency (QE) over quantum well infrared photodetectors (QWIPs) and are approaching QE values comparable with mercury cadmium telluride and indium antimonide detectors. This a major technological breakthrough, yet before we embark on an expensive in-house program to design and fabricate SLS detectors it would be very valuable to build an IR camera system using the existing SLS array we currently have and perform experimental field tests.

Strained Layer Superlattice (SLS) detectors are a new class of detectors. In our FY12 IRAD "Strained Layer Superlattice Infrared Detector Array Characterization" we verified that these devices exhibit a dramatic increase in quantum efficiency (QE) over quantum well infrared photodetectors (QWIPs) and are approaching QE values comparable with mercury cadmium telluride and indium antimonide detectors. The anticipated advantages of SLS detector technology over existing IR detectors are: high sensitivity, band-gap tunable wavelength response (similar to QWIPs), warmer operating temperatures, array spectral uniformity (yet to be realized), high temporal stability, relatively low cost of manufacturing, scalability (to very large format arrays) and multiple vendor sources all contributing to higher performing scientific instruments. Warmer and more stable focal planes lead to simpler instrument designs which result in higher reliability, longer mission lifetimes and reduced costs. In our FY12 IRAD we obtained a test SLS array and performed extensive tests to ascertain the veracity of researcher claims, as well as to assess the potential applications to NASA missions from a practical infusion standpoint. The most important result of that investigation was the verification of the (unexpected) very high QE. However, along with the dramatic improvement in QE we measured much higher dark current and the array was quite non-uniform. Before we embark on an ambitious in-house program to design and fabricate SLS detectors it would be very valuable to build an IR camera system using the existing SLS array we currently have and perform some local field tests. We believe that actual IR imaging of external environment scenery will prove most valuable.

SLS IR camera

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Table of Contents

Anticipated Benefits

This technology requires further validation before it can be considered for existing missions. However, near term prospects include upcoming Landsat missions, possibly exoplanet exploration, planetary observations yet to be defined.

The performance of the detector arrays generally defines the ultimate performance of the instrument. Implicit in this expectation is the necessary sensitivity of the specific detector technology selected for a given mission. This sensitivity is generally determined by the quantum efficiency and the noise characteristics of the detector under its operating conditions. However, in selecting a detector many more variables need to be considered such as: the costs associated with a particular IR technology, the array format availability, operating conditions, reliability, level of manufacturing complexity, technical support, reliability, replaceability and compatibility with interfacing technologies (readout ICs, frame rates etc.). Strained Layer Superlattice (SLS) detectors are a new class of detectors. These detectors may be the next generation of band-gap engineered, large format infrared detector arrays with substantially higher quantum efficiencies than existing quantum well-based (QWIPs) detectors and provide a competitive alternative to the current state-of-the-art mercury cadmium telluride detector arrays.   In our Phase I IRAD project we verified that the quantum efficiency exceeded 50%.   To adequately determine the suitability of any detector array for an instrument requires evaluation in a much more relevant environment (clearly stated, and for good reason, in the TRL definitions). To accomplish this next level of verification we need to develop a fully operational camera system using an SLS array.   If they prove to perform well in an operational environment they will be of extraordinary value to future NASA Earth science and astronomical missions.

The US Dept. of Defense is also pursuing the development and maturation of this technology as well as government and industry of foreign countries (from France to India). The industrial applications for this technology are currently being filled by Quantum Well IR detectors, microbolometers, InSb and MCT devices. However, SLS can be easily migrated into these same applications once the technology is mature enough.

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

Matt Mcgill

Principal Investigator:

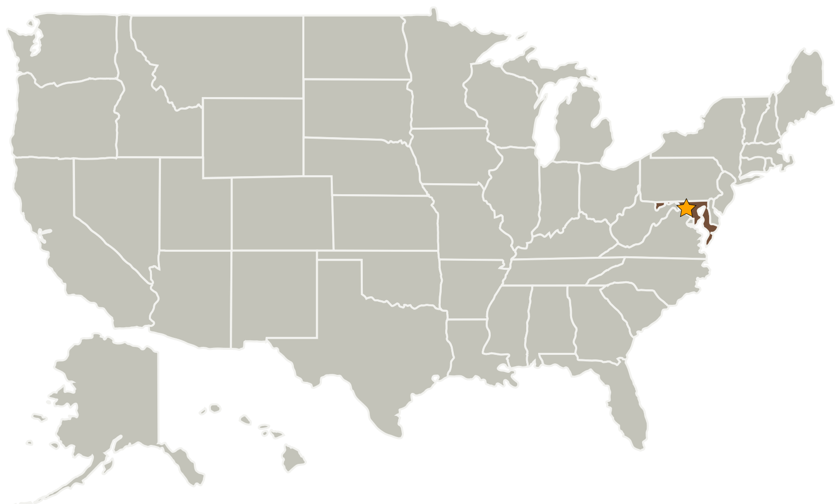
Murzban D Jhabvala

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.1 Detectors and Focal Planes

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Images

Development of Strained-Layer Superlattice (SLS) IR Detector Camera Project
Development of Strained-Layer Superlattice (SLS) IR Detector Camera Project
(https://techport.nasa.gov/image/4082)

Project Website:

http://sciences.gsfc.nasa.gov/sed/